Strongly Correlated Electrons

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Strong correlations among electrons are an essential feature in many transition metal, rare earth and actinide compounds. The large Coulomb interaction and narrow bands often lead to exciting new phenomena and/or unexpected properties. Two specific issues of correlated electrons have been studied.

• Deviations from normal metallic behavior, so-called non-Fermi liquid properties, can arise from a nesting of the Fermi surface in conjunction with the Coulomb interaction among the electrons. We have studied the renormalization group flow of the system and found instabilities to a spin- and charge-density wave. In the pre-critical region we obtained a log(T)-dependence in the specific heat and a strongly renormalized susceptibility as observed experimentally already in about 70 compounds and alloys. An instability to superconducting fluctuations was also found. The electron-phonon interaction, the phonon energies and the thermal expansion are all strongly affected in the proximity of the quantum critical point.

• CrO_2 is half-metallic ferromagnet with great potential as a spin-injector for spintronics devices. Band structure calculations predict a 1.5 eV gap for the excitations in the minority spin bands, which is not consistent with experimental findings. We have recently constructed a model of spin double-exchange between Cr sites, which is qualitatively in agreement with most of the experimental facts, i.e. the low T_C, the contribution of magnons to the specific heat and magnetization, and the activation energy in the resistivity.